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In situ hermit crab (Crustacea, Anomura, Paguroidea) from the Early Eocene (Ypresian) of NE Italy

Abstract - Hermit crabs from the Eocene of Italy have been reported by several authors who described only fragmentary and complete chelae of chelipeds. The studied specimen from the Early Eocene (Ypresian) of Monte Baldo (Verona, NE Italy) has been ascribed to *Paguristes* Dana, 1851, with *P. baldoensis* n. sp. (Diogenidae Ortmann, 1892). It represents the first report of hermit crab *in situ* from Italy.

Key words: Crustacea, Anomura, Paguroidea, Early Eocene, Italy.

Riassunto - Paguro *in situ* (Anomura, Paguroidea) dell'Eocene inferiore (Ypresiano) dell'Italia nordorientale.

Paguridi dell'Eocene d'Italia sono stati segnalati da alcuni autori che hanno descritto solo chele complete o incomplete dei chelipedi. L'esemplare studiato dell'Eocene inferiore (Ypresiano) del Monte Baldo (Verona, NE Italia) è stato ascrivito a *Paguristes* Dana, 1851, con *P. baldoensis* n. sp. (Diogenidae Ortmann, 1892). Si tratta della prima segnalazione di un paguride *in situ* per l'Italia.

Parole chiave: Crustacea, Anomura, Paguroidea, Eocene inferiore, Italia.

Introduction

As reported by Glaessner (1969), fossil hermit crabs are usually known only for the strongly calcified parts, like chelipeds and ambulatory legs, while the shield is rarely preserved. Schäfer (1972) and later Walker (1992) pointed out that “as a rule, hermit crabs are not preserved within the gastropod shell”. In fact, the fossil record of hermit crabs preserved *in situ* is exceptionally rare, limited to date to about ten specimens formerly recognized, that ranges from the Early Jurassic to the Pliocene, presumably due to a previous selective sampling in field prospections or, according to van Bakel *et al.* (2008), for merely inattention rather than of really paucity.

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Jagt *et al.* (2006) reported the earliest hermit crab *in situ* referred to *Palaeopagurus* Van Straelen, 1925, including a probable new species, from the upper Pliensbachian (Early Jurassic) of southern Germany, preserved in a fragmentary body chamber of the amaltheid ammonite *Pleuroceras solare*.

van Bakel *et al.* (2008) reported *Ammopylocheles mclaughlinae* van Bakel, Fraaije, Jagt & Artal, 2008, preserved within the body chamber of an empty perisphinctid ammonite shell from the Kimmeridgian (Early Jurassic) of southern Germany.

Fraaije (2003) reported *Palaeopagurus vandenengeli* Fraaije, 2003, preserved within the shell of the ammonite *Simbirskites gottschei* from the middle Hauterivian (Lower Cretaceous) of United Kingdom.

Breton & Collins (2007) reported a single specimen with chelipeds and ambulatory legs, poorly preserved and very compressed, of an indeterminate ?*Pagurus* sp. within a ?natacid gastropod from the Cenomanian (Late Cretaceous) of Le Mans (France).

Feldmann *et al.* (1993), described *Paguristes santamartaensis* Feldmann, Tshudy & Thomson, 1993, by two chelipeds associated with an external mould of the gastropod *Taioma* from the ?late Santonian- middle Campanian (Late Cretaceous) of Antarctica.

Fraaije *et al.* (2008) reported *Annuntidiogenes sunuciorum* Fraaije, van Bakel, Jagt & Artal, 2008, preserved within a volutoid gastropod from the Maastrichtian (Late Cretaceous) of The Netherlands.

Collins & Jakobsen (2003) described *Pagurus? langei* Collins & Jakobsen, 2003, within the body chamber of *Volutocorbis* sp. from the Eocene (Ypresian/Lutetian) of Lillebaelt Clay Formation of Jutland (Denmark).

Jagt *et al.* (2006) reported chelipeds and ambulatory legs of an indeterminate paguroid ("*Pagurus damesii*" Noetling, 1885, *nomen dubium*) within a internal mould of a ?volutid gastropod from the Middle Eocene of eastern Prussia (Russia).

Karasawa (2002) reported remains of pereopods 1-3 of *Pagurus* (s.l.) sp. preserved within *Turritella infralirata* from the Early Late Oligocene of Japan.

Hyden & Forest (1980) reported *Pagurus clifdenensis* Hyden & Forest, 1980, within a damaged shell of the gastropod *Struthiolaria subspinosa* from the Early Miocene of New Zealand.

Finally, Dunbar & Nyborg (2003) reported the discovery of three specimens of hermit crabs, ascribed to *Isocheles* sp., associated with their host gastropod shell from the Pliocene of the San Diego Formation of California (United States).

Geological setting

The mountain chain of Monte Baldo, between Verona and Trento provinces (NE Italy), expands from N to S. It is included between the eastern bank of Garda Lake and the right orographic bank of Adige River. The geological section of the eastern side of the mountain chain includes some sedimentary series from the Late Jurassic to the Late Eocene (Fabiani, 1915; Luciani, 1987, 1989). A continuous series of marly limestones and Eocene marls of marine origin crops out close to the village of Ferrara del Baldo (Verona) (Fig. 1). The bottom of the series has been referred to the Early Eocene, including different invertebrates, such as brachyurans belonging to *Harpactocarcinus* and echinoderms belonging to *Pentacrinus* (Fabiani, 1915).

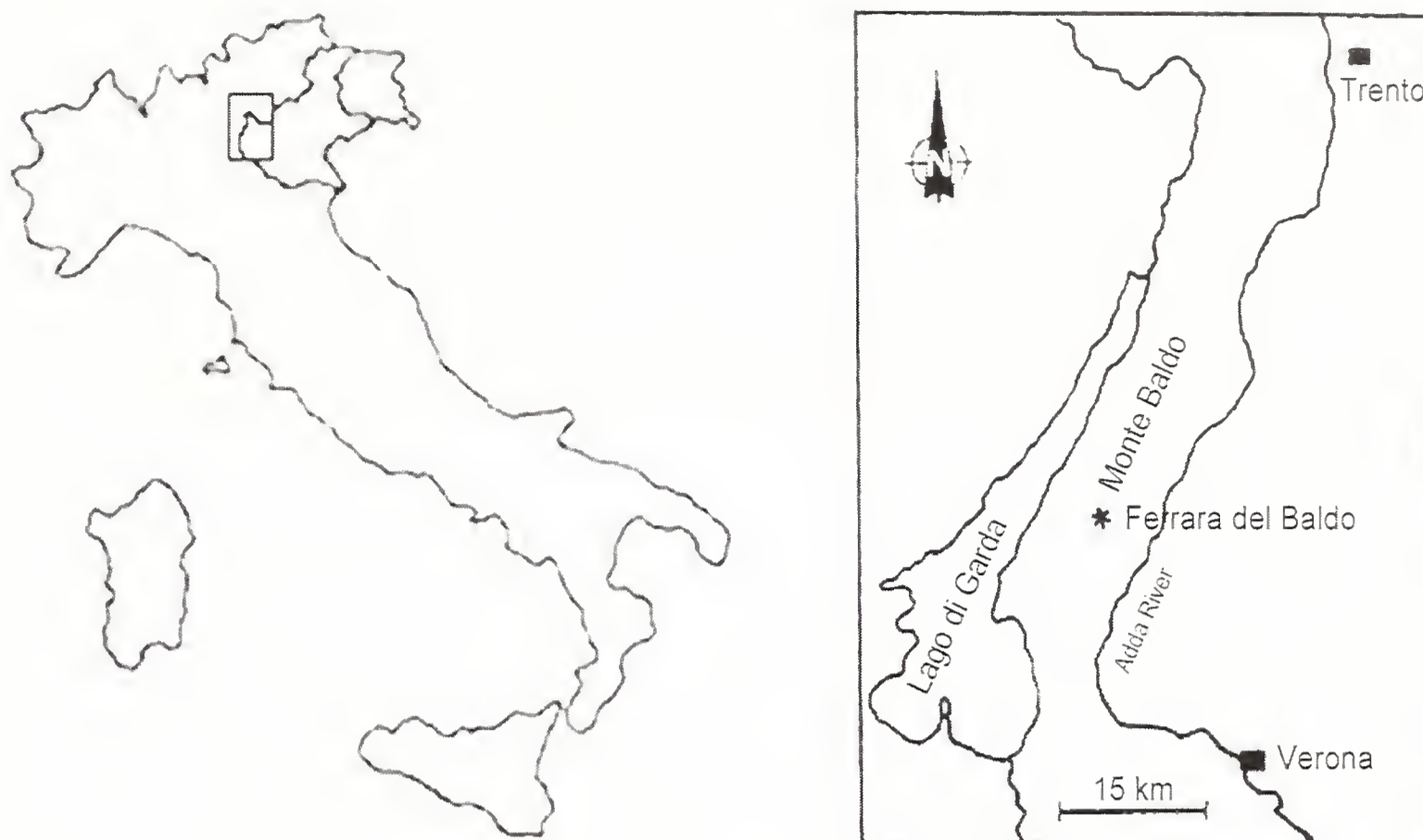


Fig. 1 – Geographical map with fossiliferous locality (*) / mappa geografica con ubicazione della località fossilifera (*).

The studied specimen was discovered in this level and therefore ascribed to the Early Eocene (Ypresian), also for the presence of one fragmentary specimen of *Pentacrinus* cfr. *P. diaboli*, typical of the Early Eocene (Fabiani, 1915; Siliotti, 1971), associated with the studied specimen within the body chamber of the coeval cerithid *Pseudovertagus*.

Previous reports of hermit crabs from the Eocene of Italy

As reported by De Angeli & Garassino (2006) and Beschin *et al.* (2007), the fossil record of Paguroidea from the Eocene of Italy includes only Diogenidae Ortmann, 1892.

Diogenidae includes *Calcinus* Dana, 1851, *Ciliopagurus* Forest, 1995, *Dardanus* Paulson, 1875, *Diogenes* Dana, 1851, *Eocalcinus* Via Boada, 1959, *Paguristes* Dana, 1851, and *Petrochirus* Stimpson, 1859. Only fragmentary and complete chelae of chelipeds are known from the Eocene of Italy to date for this family, as reported by Beschin *et al.* (1994, 2002, 2005, 2006, 2007), De Angeli (1995), and Vicariotto (1997). So the studied specimen represents the first report of hermit crab *in situ* from Italy, enlarging also the very poor knowledge about the life-style ways among the fossil paguroids.

Material

The studied specimen is preserved *in situ* in an inner mould of gastropod, probably belonging to *Pseudovertagus* (*Striovertagus*) *striatus* (Brugüiere, 1792), a cerithid usually common from the late Ypresian to middle Lutetian of Veneto (Quagiotto, pers. comm., 2008). Even though we suppose that the complete shield is

preserved within the body chamber of the second turn of the shell, only the chelae and the right carpus of chelipeds were cleaned after the preparation by air gravers due to the hard nature of the carbonatic mould of the gastropod shell. The studied specimen has been ascribed to the infraorder Anomura MacLeay, 1838, including *Paguristes baldoensis* n. sp. (Diogenidae Ortmann, 1892).

The specimen is housed in the Palaeontological Collections of the Museo di Storia Naturale, Milano (MSNM). Measurements are given in millimetres (mm).

Systematic Palaeontology

Order Decapoda Latreille, 1802
 Infraorder Anomura MacLeay, 1838
 Superfamily Paguroidea Latreille, 1802
 Family Diogenidae Ortmann, 1892

Included fossil genera: *Anmuntidiogenes* Fraaije, van Bakel, Jagt & Artal, 2008 (late Albian – Spain; Maastrichtian – The Netherlands); *Calcinus* Dana, 1851 (Lutetian – Italy; Pliocene – Italy); *Ciliopagurus* Forest, 1995 (Oligocene – Belgium; Badenian – Hungary); ?*Clibanarius* Dana, 1852 (?Late Eocene – Egypt); *Dardanus* Paulson, 1875 (Eocene – United States and Egypt; Oligocene – Asia; Lutetian – Italy; Miocene – Europe; Pliocene – Italy and Fiji; Pleistocene – United States); *Diogenes* Dana, 1851 (Ypresian – Italy); *Eocalcinus* Via Boada, 1959 (Eocene – Spain and Italy); *Eopaguroopsis* van Bakel, Fraaije, Jagt & Artal, 2008 (late Oxfordian – Germany); *Paguristes* Dana, 1851 (?late Santonian-middle Campanian – Antarctic; Campanian, Maastrichtian – United States; Maastrichtian – The Netherlands; Paleocene – United States; Lutetian and Priabonian – Italy; Miocene – United States); *Petrochirus* Stimpson, 1859 (Late Cretaceous – United States; Lutetian and Priabonian – Italy; Oligocene – W India; Miocene – Panama, N America, and N Africa; Pliocene – N America); *Striadiogenes* Garassino, De Angeli & Pasini, 2009 (Cenomanian – Lebanon) (updated after Glaessner, 1969).

Genus *Paguristes* Dana, 1851

Type species: *Paguristes hirtus* Stimpson, 1858.

Included Italian fossil species: *P. extentus* Beschin, Busulini, De Angeli & Tesier, 2007 (Early Eocene – Ypresian); *P. prealpinus* Beschin, De Angeli, Checchi & Zarantonello, 2005 (Middle Eocene – Lutetian); *P. lineatuberculatus* Beschin, De Angeli, Checchi & Mietto, 2006 (Late Eocene – Priabonian).

Paguristes baldoensis n. sp.

Figs. 2-4

Diagnosis: chelae subequal, subrectangular in outline; left chela slightly longer and larger than right chela; right chela elongate with upper and lower margins almost rectilinear; corrugated upper margin of palm; lower margin of palm straight and smooth; movable and fixed fingers elongate and strong; corrugated upper margin of

movable finger; interdigital margin strongly inclined; articulation carpo-propoidale straight; ornamentation of chela with strong tubercles not aligned.

Etymology: the trivial name alludes to Monte Baldo where the studied specimen was discovered.

Holotype: MSNM i27220.

Geological age: Early Eocene (Ypresian).

Type locality: Ferrara di Monte Baldo (Verona).



Fig. 2 – *Paguristes baldoensis* n. sp., MSNM i27220, holotype / olotipo (x 2).

Occurrence: one specimen *in situ* that preserves only the chelipeds.

Length of carpus of right chela: 4

Length of right chela: 8

Length of palm of right chela: 5

Width of palm of right chela: 4

Length of left chela: 10

Length of palm of left chela: 5

Width of palm of left chela: 5

Length of fixed finger of right chela: 4

Length of movable finger of right chela: 6

Maximum length of shell: 60

Maximum width of shell: 20

Description. Left and right chelae subequal in size, subrectangular in outline, strongly broader proximally; left chela slightly longer and larger than right chela; the upper margin is slightly curved and corrugated; the lower margin is straight and smooth, continuous with the stout fixed finger and smooth from the tip of the fixed finger to the carpal margin; the palm is subquadrate in outline; the interdigital margin is strongly inclined, smooth, with two slight depressions divided by a medial slight bulge; the fixed finger is almost as long as the palm with the tip shallowly spooned; the movable finger is stout, elongate, with corrugated upper margin and lateral pits; the outer surface of the left and right chelae is gently convex with strong tubercles not aligned and uniformly distributed; the articulation carpo-propoidale is straight; the carpus is subquadrate in outline with the carpus-merus articulation less wide than the carpo-propodiale articulation; upper margin of carpus smooth and gently inflated laterally.

Discussion. As reported by many authors, the systematics of Recent Paguroidea uses essentially morphological dorsal and ventral characters of the body to distinguish genera and species of each family. Since, the studied specimen does not preserve dorsal or ventral characters useful for its identification, only the shape of the chelae of chelipeds and the ornamentation of chelipeds can be used for its taxonomic ascription.

As reported by McLaughlin (2003) the superfamily Paguroidea includes at present the following Recent families, Coenobitidae Dana, 1851, Pylochelidae Bate, 1888, Diogenidae Ortmann, 1892, Lithodidae Samouelle, 1819, Pylojacquesidae McLaughlin & Lemaitre, 2001, Paguridae Latreille, 1802, and Parapaguridae Smith, 1882.

Comparing the general morphology of the chelipeds of the studied specimen with the diagnostic characters of these families (McLaughlin & Lemaitre, 2001; Poore, 2004), it is assigned to the Diogenidae and to *Paguristes* Dana, 1851, for the chelae subequal, the palm subquadrate having a corrugated upper margin, and the interdigital margin strongly inclined.

In the fossil record from the Eocene of Veneto, *Paguristes* is represented with three species, *P. prealpinus* Beschin, De Angeli, Checchi & Zarantonello, 2005, *P. lineatuberculatus* Beschin, De Angeli, Checchi & Mietto, 2006, and *P. extentus* Beschin, Busulini, De Angeli & Tessier, 2007. A morphological resemblance exists between the studied specimen and *P. extentus* for the elongate outline of the chela and the interdigital margin strongly inclined and smooth. However, two characters distinguish the new species from *P. extentus*, the stout fixed finger almost as long as the palm with the tip shallowly spooned and the corrugated upper margin of

the palm. The elongate chelae subequal with corrugated upper margin, the elongate movable finger with corrugated upper margin, the interdigital margin strongly inclined, smooth, with two slight depressions divided by a medial slight bulge, and the ornamentation of palm with strong tubercles not aligned distinguish *P. baldoensis* n. sp. from *P. prealpinus* and *P. lineatuberculatus*, both having a fixed finger with distal tip directed downwards, interdigital margin slightly inclined and straight, and ornamentation of palm with small tubercles.

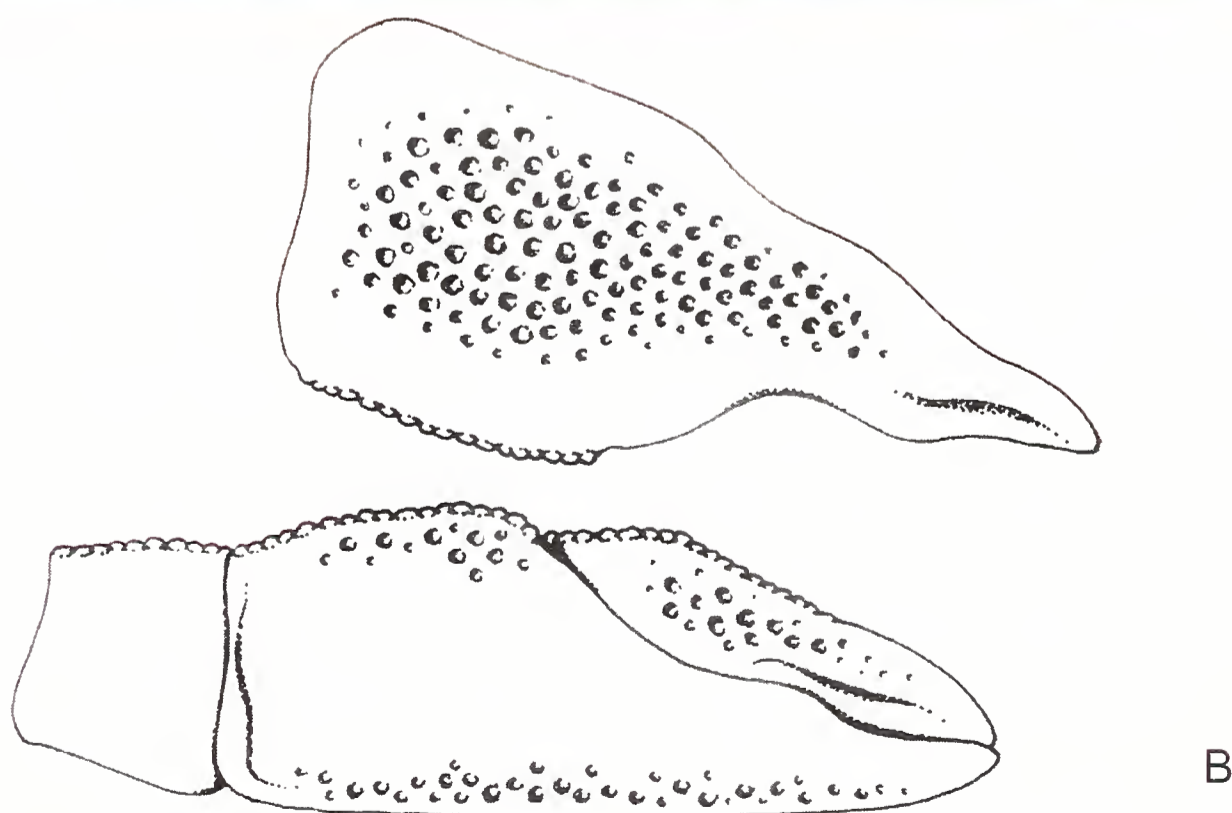


Fig. 3 – *Paguristes baldoensis* n. sp., MSNM i27220. A) detail of the chelae / dettaglio delle chele. B) reconstruction of the chelae / ricostruzione delle chele. (x 6).

Taphonomic and palaeoecological notes

The studied specimen shows both chelipeds exposed, ranged subparallel in lateral view and in life position. The original shell, probably belonging to *Pseudovertagus* (*Striovertagus*) *striatus*, was dissolved during the diagenesis process and only the general form of the helicoidal spire, laterally compressed, and the outline development are visible, as internal mould. This kind of preservation allows to recognize the presence of the chelae into the shell.

Recent species of *Pseudovergatus* live on sandy bottoms and soft sediments in subtropical intertidal-sublittoral and brackish waters near the costal line. A similar environment is supposed for the Eocene in Veneto area, intercalated with local important volcanic events.

Moreover, some Recent small sized hermit crabs living in the Mediterranean Sea, such as *Clibanarius erythropus*, have a preference to inhabit the empty shells of several Cerithiidae in addition to a few other gastropods (Grecchi & Balestrazzi, 2002).

Other extra-Mediterranean examples are the “hermited” shells (*sensu* Walker, 1992) of Recent *Cerithium stercusmuscarum* from the Cortez Sea (Mexico) (Walker, 1992). As reported by Tunberg *et al.* (1994), also the small shells of *Cerithium muscarum*, in the estuarine subtropical environment of the Indiana River Lagoon on the Atlantic coast of Florida (United States) are observed as an important habitat resource for *Pagurus maclaughinae*. Another example is *Diogenes pugilator* Roux, 1828, inhabiting the shells of *Cerithium vulgatum* along the coastal environment of the Crimea Peninsula in the Black Sea.

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